Organic Microelectronics Based on Polymer Nanostructures

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Remarkable developments in nanotechnology in the last decades have almost reached the fundamental physical limitations and the miniaturization threshold for electronic devices made of conventional semiconductors. This has accelerated the interest in nanostructured organic materials and devices, which have the ability to control their properties on nanoscale, and even on molecular level. These nanostructures including different organic molecules, oligomers, polymers and even biological objects, like DNA, are the subject of intensive research aiming for molecular electronics application such as light emitting diodes (LEDs), field-effect transistors (FETs), conducting elements of all-polymer integrated circuits, *etc*.[1]

Many of these organic electronic devices could be successfully realized at the micro-scale first, using the very promising printing technology[2] and subsequently on the nanoscale. They reach performance levels comparable to or even better than their inorganic counterparts. Thus, the model conjugated polymer, polyacetylene, becomes highly conducting (up to 10^5 S/cm) after doping; it also has a fibrous structure with a typical diameter of several tens of nanometers, which can be used as a molecular wire and as an active element in FET nanostructures. The progress in organic nanotechnology is very rapid. It might suggest, that the future evolution in this area will linked up with the fabrication of various devices based on a single self-assembled molecular (SAM) layers and molecular arrays with a thickness down to 10-20 Å. These two-terminal molecular rectifiers and tree-terminal SAM FETs could be used to implement simple molecular electronic computer logic circuits. The conduction mechanism in the single polymer nanofiber and on the single molecular scale is not completely understood yet. Thus, this knowledge could be an essential task for the future trends in nano-scale device fabrication. With molecular heterostructures and molecular wires it might be possible to combine the insulating and semiconductor properties of such low-dimensional organic structures as well as the contacts within a single molecule or supramolecular architecture.

Can these organic nanostructures compete with devices made of traditional semiconductors? I think so, indeed I am sure of it! All the above arguments go to prove that we are on the verge of a revolution in microelectronics: from inorganic semiconductors towards to nano-scale plastic electronics. The Nobel Prize awarded A. J. Heeger, A. G. MacDiarmid and H. Shirakawa in 2000 has stressed the importance of this area and convinced us that we are on the right way.

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[1] M. C. Petty, M. R. Bryce, and D. Bloor, eds., *Introduction to Molecular Electronics*, London: Edward Arnold, 1995.

[2] G. Yu and A. Heeger, in: M. Schleffer and R. Zimmerman, eds., *The Physics of Semiconductors*, Vol.1, Singapore: World Scientific, 1996.